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The Goosander and Red-breasted Merganser as Predators of Salmon in Scottish Waters

By D. H. MILLS, M.Sc.

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Freshwater Fisheries Laboratory, Pitlochry

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The Goosander and Red-breasted Merganser as Predators of Salmon in Scottish Waters

INTRODUCTION

Among the predators of the young stages of salmon are species of fish-eating ducks known as mergansers or sawbills. The two most important species in relation to salmon economy are the goosander (*Mergus merganser*)* and the red-breasted merganser (*M. serrator*).

The effects of American merganser predation on the stock of young salmon has been studied in eastern Canada by White (1937, 1939a, 1939b and 1957) and Elson (1950, 1952, 1957 and 1962), who have demonstrated an increase up to fivefold in Atlantic salmon smolt production following 'merganser' control. Munro and Clemens (1937) found that, in western Canada, although the American merganser took the eggs and young of Pacific salmon, it could not be considered to affect the production of salmon and trout adversely to any appreciable degree because its numbers were not excessive and its food largely consisted of worthless fish. Sayler, Clark and Lagler (1940) found that, in Michigan, 'merganser' control was only necessary when occasional large concentrations of American mergansers occurred on streams and hatchery ponds in winter. Lindroth (1955) and Peterson (1956) found that these birds were of sufficient importance as salmon predators in the Swedish river Indalsälven to warrant control. Heard and Curd (1959) found, from an examination of American mergansers caught in gill-nets set in an Oklahoma reservoir, that these birds in that region should be beneficial as their diet was largely composed of coarse fish. Madsen (1957) found that goosanders frequenting freshwater habitats in Denmark fed to a considerable extent on cyprinoids.

White (1937 and 1939b), Munro and Clemens (1939) and Aass (1956) concluded that, while on freshwater and feeding in the same areas, there is no difference in the feeding of the red-breasted merganser and the American merganser. Sayler, Clark and Lagler (1940) found the red-breasted merganser to be of little or no importance to fish management in Michigan.

Little information is available on the role these two species play in the economy of Atlantic salmon in Scotland although Lee (1896), Maxwell (1904), Berry (1936) and Hardy (1951) give instances of their taking young salmon. Moreover, the practice of paying rewards for these birds by certain District Fishery Boards and angling clubs in Scotland suggests that they are considered to do some damage to salmonid fish stocks in certain areas. Neither species is protected in Scotland under the Protection of Birds Act, 1954.

FOOD

(*a*) Goosander

Goosanders inhabit the upper reaches of rivers and their small tributaries and also inland lochs. In winter they are to be found gathering on lochs and reservoirs.

A total of 147 goosander stomachs have been examined from the following Scottish waters: Rivers Dee (Aberdeenshire) (35), Ness (27), Bran (18), Tweed (15), Meig (10), Garry (Inverness-shire) (9), Tay (7), Conon (5), North Esk (4), Easter Carron (3), Beauly (3), Spey (3), Garry (Perthshire) (2), Tummel (2), Blackwater (1) and Oich (1), Loch Choin (1) and Loch na Croic (1). Of the 147 stomachs examined 23 were empty. Details of the contents of the remaining 124 stomachs are given in Table 1.

* This species is known in North America as the American merganser (*M. merganser americanus*).

TABLE 1

Percentage occurrence of various food organisms in the stomachs of goosanders.

Food organism	Percentage Occurrence
Salmon (*Salmo salar*)	57·2
Salmonid fish remains	19·2
Eels (*Anguilla anguilla*)	14·5
Brown trout (*Salmo trutta*)	9·7
Perch (*Perca fluviatilis*)	9·7
Insects*	6·4
Minnows (*Phoxinus phoxinus*)	4·0
Pike (*Esox lucius*)	2·4
Sea trout (*Salmo trutta*)	0·8
Gudgeon (*Gobio gobio*)	0·8
Miller's thumb (*Cottus gobio*)	0·8
Birds†	0·8
Mammals‡	0·8

* These were adult Diptera and Coleoptera and trichopteran larvae (mostly *Lepidostoma* spp.)
† Unidentified
‡ The water shrew (*Neomys fodiens*).

Other items present in the stomachs included 122 tags from salmon smolts, three fish hooks and stones from the bird cherry (*Prunus padus*) or a related species.

It was possible, in 96 of the stomachs, to count the number of fish eaten and the results are shown in Table 2.

TABLE 2

Numbers of fish eaten by goosanders

Species	Number found
Salmon (*Salmo salar*)	235 (71·0)
Perch (*Perca fluviatilis*)	28 (9·4)
Brown trout (*Salmo trutta*)	30 (9·1)
Eel (*Anguilla anguilla*)	26 (7·9)
Minnow (*Phoxinus phoxinus*)	6 (1·8)
Pike (*Esox lucius*)	3 (0·9)
Sea trout (*Salmo trutta*)	1 (0·3)
Gudgeon (*Gobio gobio*)	1 (0·3)
Miller's thumb (*Cottus gobio*)	1 (0·3)

Figures in brackets indicate the percentages of the total number of fish found.

These results show that the salmon is by far the most important food item in the diet of the goosanders examined. Salmon are present in the diet of the young birds within a few weeks, if not days, of hatching. Fish were found in a duckling (weighing 105 g.) on 7th July, 1960, and whole salmon parr and fry have been found in juveniles weighing between 250 and 350 g. White (1957) found that goosander ducklings changed from an insect to a predominantly fish diet when they weighed about 85 g. Fabricius (1956) describes young birds in Sweden taking adult Trichoptera and the crustacean, *Neomysis vulgaris*. White (1957) also found that when ducklings were small they took small fish but, as they increased in size, they took larger fish. This is also found to be generally true in Scottish waters although adult birds were also found to take small fish and 15 salmon fry were found in one adult duck. A pair of adults were shot on a small tributary of the Inverness-shire Garry in April, shortly after the release of unfed salmon fry from Invergarry Salmon Hatchery, and were found to have eaten a number of these fish. White (*loc. cit.*) also noted that the largest fish were taken by adult drakes. The largest fish recorded from the Scottish birds examined was a pike 31.0 cm. long from an adult drake on the River Beauly.

It is interesting to note the percentage of eels present as Coldwell (1939) found that the diet of these birds in certain parts of eastern Canada in winter consisted almost entirely of eels and suggested that the birds should be given credit for killing these fish, which are detrimental to salmonids. Bolam (1912, p. 413) found an eel of 46.0 cm. in a bird shot on the River Tweed at Carham.

Both Lindroth (1955) and Peterson (1956) found miller's thumbs in birds shot on the River Indalsälven in Sweden and Lindroth pointed out that this fish species is a predator of salmon eggs and young.

Young salmon were found to be present in the diet of goosanders practically the whole year round and constituted between 53% and 86% (by number) of their stomach contents when examined. When goosanders are feeding on lochs and reservoirs during the winter months their diet may be different. Andrew (1956) records an adult goosander drake shot on Loch Leven, Kinross, as having fed entirely on small perch about two inches long and perch have been found in the stomachs of goosanders shot on Lochs a'Chuilinn and Achanalt, on the course of the River Bran, Ross-shire. When on lochs, goosanders may well feed on trout and, when on lochs in the course of a salmon river, on young salmon as well.

(*b*) Red-Breasted Merganser

The red-breasted merganser is more of an estuarine species than the goosander and frequents the lower reaches of river systems, estuaries, sea lochs and firths. However, there is an overlap in the distribution of the two species and the red-breasted merganser may be found well inland on the larger river systems such as the Tay, Spey and Ness.

A total of 148 stomachs from red-breasted mergansers have been examined from the following areas: Rivers Conon (40), Ness (37), Tay (22) and Aberdeenshire Dee (19), Inverness Firth (4), River Spey (4), Loch Faskally (4), River Garry (Perthshire) (3), Cromarty Firth (2), Loch Achonachie (2), Rivers Alness (2), North Esk (2) and Polly (1), Dornoch Firth (1), Rivers Easter Carron (1), Orrin (1), Garry (Inverness-shire) (1) and Tummel (1) and Enard Bay (1). Of the 148 stomachs examined 34 were empty. The contents of the 114 stomachs containing food are given in Table 3.

TABLE 3

Percentage of various food organisms in the stomachs of red-breasted mergansers

Food Organism	Percentage Occurrence
Salmon (*Salmo salar*)	42·5
Fish remains (mostly salmonid)	31·8
Brook lampreys (*Lampetra planeri*)	6·2
Crustaceans	6·2
Insects	5·3
Eels (*Anguilla anguilla*)	4·4
Perch (*Perca fluviatilis*)	3·5
Flounders (*Platichthys flesus*)	3·5
Three-spined sticklebacks (*Gasterosteus aculeatus*)	2·6
Minnows (*Phoxinus phoxinus*)	1·8
Common gobies (*Gobius minutus*)	1·8
Brown trout (*Salmo trutta*)	0·9
Butter fish (*Pholis gunnellus*)	0·9
Coal fish (*Gadus virens*)	0·9

Other items found in the stomachs included 36 tags from salmon smolts, tagging wire and a fish hook. The insects, with one exception, were found in birds of the year and were all trichopteran larvae (mostly limnophilids). Aass (personal communication) found the young of the red-breasted merganser in Norway to have eaten larvae of Ephemeroptera, Trichoptera, Plecoptera and Chironomidae. The crustaceans were mysids, the common shrimp (*Crangon vulgaris*), the shore crab (*Carcinus maenas*) and the freshwater louse (*Asellus* spp.). In 69 of the stomachs it was possible to count the number of fish eaten and the results are given in Table 4.

TABLE 4

Numbers of fish eaten by red-breasted mergansers

Species	Number found
Salmon (*Salmo salar*)	113 (48·0)
Brook lamprey (*Lampetra planeri*)	47 (20·0)
Minnow (*Phoxinus phoxinus*)	41 (17·4)
Common goby (*Gobius minutus*)	11 (4·7)
Eel (*Anguilla anguilla*)	6 (2·6)
Three-spined stickleback (*Gasterosteus aculeatus*)	5 (2·1)
Flounder (*Platichthys flesus*)	5 (2·1)
Perch (*Perca fluviatilis*)	4 (1·7)
Brown trout (*Salmo trutta*)	1 (0·4)
Butter fish (*Pholis gunnellus*)	1 (0·4)
Coal fish (*Gadus virens*)	1 (0·4)

Figures in brackets indicate the percentage of the total numbers of fish found.

While on freshwaters in Scotland, salmon appear to be the most important item in the diet of the red-breasted merganser, but lampreys, eels and minnows are also of importance.

Many of the brook lampreys were taken in the spring at their spawning time as those found in birds from the River Conon had their body cavities distended with ova, some of which had been shed. Peterson (personal communication) also found that river lampreys (*Petromyzon fluviatilis*) moving into the Swedish river Indalsälven in the autumn prior to spawning in the spring were taken in large numbers below Bergeforsen Dam by these birds.

Eels have also been found in the diet of red-breasted mergansers in Scotland by Gray (1871) and Berry (1936), in England by Browne (1902) and in Ireland by Piggins (1959). Berry (1936) considered that, when red-breasted mergansers were on freshwater, they seemed to have a particular preference for small eels and sticklebacks, even when other species of fish were abundant. Millais (1913) found pike in birds shot on a backwater of the River Tay.

Those birds shot in the marine habitats of the Dornoch, Cromarty and Inverness Firths on the east coast and Enard Bay on the west coast of Scotland had eaten mysids, common shrimps, shore crabs, flounders, common gobies, butter fish and coal fish. This corroborates the findings of Campbell (1947) who reported similar food items in red-breasted mergansers on Benbecula and North Uist in the Outer Hebrides. Macgillivray (1852, p. 221) recorded sand eels in birds from the Outer Hebrides and, according to Harvie-Brown and Buckley (1888) their gaelic name 'siolta' is derived from 'siotag', the sand eel, 'upon which the merganser principally feeds.' Berry (1939) found that birds shot in the Firth of Tay had been feeding almost exclusively on young herring, sprats and smelt.

In the present investigation little difference was found in the size of fish taken by the red-breasted merganser and the goosander although the largest fish recorded was from the latter species which is the larger of the two. The lengths of young salmon taken by both species are approximately the same. Although the red-breasted merganser is an almost completely marine species during the winter months salmon parr have been found in its diet at this time.

DISCUSSION

The goosander and the red-breasted merganser are both fish-eaters and, as they occur on those parts of many salmon rivers in Scotland where few other species of fish occur, salmon are likely to form the bulk of their diet. Where other species of fish are more abundant they are often taken more frequently than salmon (Munro and Clemens 1937, 1939; Aass, personal communication). Lindroth (1955) however, believes that the goosander shows a preference for young salmon, as, in areas where other fish such as the grayling were more abundant, the birds had mainly eaten salmon. This may, however, have been due to the habits of the grayling which, after their first year, frequent quieter and deeper water. Peterson

(1956) discusses this in relation to the presence of underyearling grayling in the stomachs of these birds. White (1957) suggests that American mergansers select young salmon as food but he qualified this suggestion by pointing out that these birds feed by sight and therefore need clear water which is typically the habitat of salmon and trout.

Some estimate of the food consumption of the goosander was obtained from two birds shot on the River Bran, Ross-shire in 1960. These two birds contained respectively 30 and 32 tags from salmon smolts. These tags had been attached to hatchery-reared smolts, of which 250 had been liberated only three days previously, in the area in which the birds were shot. Thus, within this period of three days, each of these birds had eaten about 42 ounces of fish. This estimate agrees closely with that of White (1957) using tame birds and it is therefore tempting to use such estimates as a basis for calculating the food consumption of goosanders over longer periods, for example, White calculated that it took 1584 salmon parr to rear each American merganser to full size. There are, however, evident dangers in producing long term estimates from short period observations in this way, especially when the short term estimates are based on feeding in captivity (White) or circumstances where food may be unusually abundant (e.g. after the addition of hatchery-reared smolts to a small Highland river).

The hatchery-reared fish may also have been particularly vulnerable because the silver wire tag which they carried made them unusually conspicuous. This is not necessarily so, however, as Peterson (personal communication), who has found as many as 25 smolt tags in a goosander, found that smolts with internal tags had been eaten as well as those with external tags and that the proportion of each eaten were similar to the proportion tagged by each method.

In assessing the status of the goosander, however, it should be pointed out that they also eat salmon predators such as trout, eels, pike, miller's thumbs and water shrews. In the present investigation these predators formed about one quarter of the goosander's diet.

From the examination of the stomachs of red-breasted mergansers killed on Scottish freshwaters it is apparent that salmon forms a much larger part of the diet than was found to be the case by White (1937, 1939b and 1957) in a study of 60 stomachs from a variety of freshwater habitats. He concluded (1957) that red-breasted mergansers tended to feed in quiet weedy waters and his observations were confirmed by Lindroth (1955). Perhaps the nature of most Scottish rivers, with their comparatively short courses, makes them more accessible to this species which may easily reach young salmon habitats relatively close to the coast. For this reason the large concentrations of red-breasted mergansers which occur along the coast in winter, especially in the estuaries and firths, are probably the source of intermittent salmon predation. While in a marine habitat these birds only appear to eat unimportant organisms.

Elson (1962) discusses the effects of the control of American mergansers on smolt production in rivers of eastern Canada. He points out that the average population density of the bird predators on these streams was about 10 birds per 15 miles of stream of 10 yards width (about 1 bird per 6 acres) but until the population density was reduced to 3 birds/15 miles/10 yards width (about 1 bird per 18 acres) the effect of this control is slight. Reduction of the bird predator population below this level, however, has an increasingly advantageous effect on smolt production down to a population density of 1 bird/15 miles/10 yards (about 1 bird per 55 acres) but any further reduction has little effect. Mills (1962), in an account of the distribution of the goosander and red-breasted merganser in Scotland, gives the population density of the goosander on the Rivers Bran and Meig (Ross-shire) as between 2 to 3 birds per 10 miles of stream of 20 yards width (about 1 bird per 24 acres). This suggests that the goosander population of these Scottish rivers is roughly at a level where, according to Elson, control should have an effect on smolt production, but White (1957) and Elson (1962) state that control in other areas on the basis of the findings for eastern Canadian streams may not be biologically justified. The population density of young salmon in some salmon rivers in Scotland is, however, similar to that of the salmon rivers in the Canadian Maritimes. Further, the frequency of salmon in the diet of Scottish birds is, if anything, a little higher than in that of Canadian birds (White, 1957) and while many other species of fish (e.g. trout, chub, dace suckers and minnows) occur in Canadian streams few fish species other than trout, which is also of importance, occur in Scottish salmon streams. It is therefore suggested that control of these birds in Scottish streams should have an effect on smolt production.

A number of District Fishery Boards in Scotland offer rewards for the destruction of goosanders but, although Jackson (1957) expressed fears that this practice would cause these birds to become extinct, there is little evidence that desultory control of this character has done more than keep the numbers of goosanders in check. Berry (1939) and Baxter and Rintoul (1953) refer to the spread of goosanders and red-breasted mergansers in spite of attempts at control. Elson (1962) considers that casual shooting of mergansers is not an adequate means of control and that effective control will only be achieved if shooting is planned on a systematic basis to extend over the whole year.

Present evidence therefore suggests that systematic control of the goosander on the Bran and the Meig should lead to an increase in smolt production and the same conclusion may well apply to many Scottish salmon rivers, but no information on the density of red-breasted mergansers is at present available. Further studies of the ecology and behaviour of both goosanders and red-breasted mergansers should be made in order to give a clearer picture of the role they play as predators on salmon.

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SUMMARY

1. Examination of the stomach contents of 147 goosanders and 148 red-breasted mergansers from Scottish waters reveals that both species had mainly eaten young salmon. They had also eaten other predators of young salmon, such as trout, eels, pike, miller's thumbs and water shrews. Other coarse fish also occurred in their diet.

2. An estimate is made of the consumption of young salmon by the goosander.

3. The importance of the goosander and red-breasted merganser as predators of salmon is discussed in the light of information on their distribution and population density on Scottish waters and of work on these predators carried out in eastern Canada.

4. It is concluded that systematic control of the goosander population may well result in an increase in smolt production, but that further studies should be made of the behaviour and ecology both of the goosander and the red-breasted merganser so that a fuller assessment could be made of their role as predators on young salmon.

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